ART. XI.—*Localization of Diseased Action in the Osseous System.*

By HARRISON ALLEN, M. D.

THE relations believed to exist between cause and effect, as observed in cases of assumed idiopathic origin, seem to us to be well worthy of investigation. The opinion that in conditions of systemic disturbance, symptoms arise in obedience to the operations of general laws, appears to be well founded. The truth of this may have been conceded long ago, but whether so or not, it has been so rarely pointed out in medical works that we feel warranted in dwelling upon the subject in some detail.

Among the occasional allusions noticed in the writings of practised observers may be mentioned the following:—

The elder Colles[1] definitely asserts, with respect to the effects of age influencing diseased action, that the "periods of life have some concern in the prevalence of disease in one class of bones over another; in very early life, say from the age of seven years to twenty-one, the long bones are mostly affected, while from thirty to thirty-five years of age the flat bones more frequently suffer."

> "The various osseous processes for muscular insertion, and the several surfaces of bony contact in the vertical plane of the trunk, are the portions of the skeleton most liable to undergo excessive waste—the former by traction, and the latter by pressure; and they are the portions, consequently, most liable to quantitative errors of nutrition."[2]

Again, apart from the acknowledged aphorism that an organ is most liable to become the seat of disease when "its functional and vascular activity bears the greatest ratio to that of other organs of the body,"[3] it is highly probable that a developmental activity conduces to a similar result; thus, H. Gray[4] found "myeloid tumours occur at an early period of life and within the period in which the cellular forms (characteristic of the growths) form a constituent part of the normal medulla. * * * It is a remarkable circumstance also that in every one of these cases the tumours have taken their origin in the epiphysal ends of the long bones."

Mr. Paget,[5] while apparently mistrusting the value of such reflections, gives proof in the following extract that in his method of research they at times held a place.

"The cases of this singular disease (cartilaginous tumours of the hand) have shown great diversity as to the cause of the tumours, and in their modes and rates of growth; some making progress, some remaining stationary, and I believe it has often happened that at the time of manhood all have ceased to grow. * * * It would be easy and as vain as easy, to speculate on the meaning of such a disease as this. I believe no reasonable explanation can yet be given, unless it may be said that these are the results of an exuberant nutrition similar to that which in the embryo may produce supernumerary limbs, but is here more disorderly and less vigorous."

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[1] Surgical Lectures, 1845, 316.

[2] Simon's Lectures on Pathology, 1850, p. 88.

[3] Barlow, Guy's Hospital Reports, Series I., vol. vii.

[4] Myeloid and Myelo-Cystic Tumours of Bone, Med.-Chir. Trans., xxxix. 144.

[5] Lectures on Tumours, 1853, 201.

With respect to degrees of vascularity of an organ influencing the form of disease attacking it, Maurice Colles[1] employs the following emphatic language:—

"The degree of vascularity of an organ determines the direction of morbid action. Thus, encephaloid is more frequent than scirrhus in the mamma during its active stage, while scirrhus is oftener seen than encephaloid after that period. Certain vascular organs, such as the testicle and tongue, are rarely, if ever, affected with scirrhus."

Another instance, rather quaint than otherwise, is illustrative of the endeavour to ascertain the causes of localization of diseased action.

Mr. Wilks,[2] in a report of a case of cartilaginous tumour of scapula, says:—

"It may not be uninteresting to observe that during the period in which this tumour was being so rapidly developed on the shoulder, similar structures to those which it contained were being as quickly produced in the fœtal structures in the uterus of the patient, she being at the time pregnant."

For the sake of convenience we propose arranging our subject matter under the following heads:—

(1.) Development and Growth of Bone.
(2.) Vascular Supply of Bone.
(3.) Relations of Bone to Muscle.

(1.) DEVELOPMENT AND GROWTH OF BONE.—*Bones may be said to maintain in their Diseases relations to their Methods of Development and Growth.*

(*a*) The human embryo, in the early stage of development, is divided into two layers—an animal or nervous, and a vegetative or mucous. The latter has a remote connection with the skeleton, save in the region of the face. Here every bone excepting the malar is in contact with a mucous surface. The connection is slight with the inferior maxillary, but decided with the inferior turbinated bones and the ethmoidal scrolls. Indeed, the latter would appear to derive their chief source of nourishment from vessels going primarily to the mucous membrane. Such an arrangement of bones asserts a definite relation with the functions of respiration and alimentation, and it might with propriety be said to have a splanchnic significance.[1]

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[1] Diagnosis and Treatment of Cancer and the Tumours Analogous to it, 1864, 42.

[2] Guy's Hospital Reports, Third Series, II., 1856, 5.

A glance at the diseases of the facial bones would appear to confirm this view of their relations. The nutritive processes within the jaws are largely dependent upon the presence and condition of the teeth. In smallpox, measles, and scarlet fever, diseases affecting the mucous and integumental surfaces, we may have necrosis of the jaw as a sequela. In typhoid fever, in which the lesions are chiefly of the mucous tract, we may find associated parotiditis, and maxillary necrosis as a sequela. Again, the "melting away" of the turbinates in the secondary stage of syphilis follows upon specific inflammation of membrane covering them.

(*b*) In tracing the development of the head we learn that the brain-case sends a vertical prolongation—the frontal process—from its vertex downwards in the median line of face, to terminate on the level of the floor of the nose. Within it originate the nasal and intermaxillary bones, with part of the ascending process of superior maxillary bone. It meets with a horizontal prolongation of the base of the cranium—the nasal septum. The lateral portions of the face, the upper and lower jaws, advance from the sides, to unite with the above to inclose the scrolls of the olfactory capsules, viz., the inferior turbinated bones and the lateral masses of the ethmoid.

We detect in the ethmoidal and vomerine elements a projection of the primordial skull into the region of the face. These pertain, therefore, to the former in their morphic relations, but to the latter in being covered with mucous membrane.

Applying these facts to pathology, we find that in consequence of the distinction of the superior maxillary bone into lateral and median portions, the latter, or inter-maxillary region, may be separated as a sequestrum when necrosis does not involve the former.[2] Necrosis of the upper jaw, when commencing in the alveolar region, rarely crosses the median line. In edentulous skulls it is not unfrequent to see the alveolar ridge of the incisorial portion of the dental arch resisting absorption a longer time than the lateral. With respect to the nasal septum, it is singularly free from disease[3] or deformity. Its chief abnormality is deflection, a result of the vomer and perpendicular plate of the ethmoid continuing to grow subsequent to the walls of the cavity of the nose becoming fixed.

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[1] "The teeth in the early embryonic conditions are developed from and are dependencies of the mucous membrane of the mouth. * * * * We have strong grounds for the hypothesis that all the bones of the face, which are developed in the walls of the primitive cavity of the mouth which they surround, are in their anatomical and physiological relations splanchnic, connected with digestion or respiration, rather than parts of the endo-skeleton of animal life."—*Wyman, Nervous System of Rana pipiens, Smithsonian Contributions*, 1852, v. 41.

[2] Bryant, Guy's Hosp. Rep., 1869, 238.

[3] C. H. Moore, in Trans. Path. Soc., 1868, xix. 332, narrates the following case of "chondro-facial enchondroma:" Male, aged 22. Tumour of five years' duration. It involved frontal bone and base of nose, and protruded in the median line of face.

Heyfelder[1] narrates a case of destruction of nasal septum from a large exostosis, involving the nasal, lachrymal, palatal bones, with the body and nasal processes of both superior maxillaries, the palatine process of the latter bone being preserved.

(*c.*) The bones of the base of the skull, viz., the occipital (excluding the supra-occipital portion), the sphenoid, the temporal (excluding the squamous portion, and styloid process), arise from cartilage. All the portions excluded in the preceding paragraph, the ethmoid bone and vomer, the parietal and frontal, together with the process extending into the face (yielding the nasal and intermaxillary portions of the superior maxillary bone), are derived from membrane.

Disease rarely involves both these regions in the same subject. Should the base of the skull be affected, the vertex is exempt, and *vice versâ.* Ordinary care must be taken in examination of diseased crania with respect to this point, not to confound primary with secondary lesions.

(*d.*) Sinuses are largest, as a rule, in bones which from the standpoint of development are most complex, that is to say, have the greatest number of centres of ossification. Thus, the superior maxillary bone has certainly three, perhaps seven centres; the sphenoid has five; the ethmoid and frontal together, four.

Now it is well known that fibroid growths, exostoses, etc., very commonly originate within and from mucous sinuses. Is it not more than coincidental that expressions of hypertrophy should be most frequent in localities where the greatest number of centres of growth have early coalesced?

(*e.*) The brain-case, considered as a collection of bones designed to protect the brain, constitutes to a limited extent a physiological as well as a mechanical unit. The centres composing it become weakened in individual force after closure of the sutures, so that a diseased process is rarely confined to an embryonal area.

It is a fact worthy of notice, that while in the growing cranial bone we find its greatest thickness in the position of its centre of ossific deposit, in

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It originated within, and was for the most part confined to the nasal septum. It here formed a rounded mass, smoothly covered on its sides, as well as above and below, by the two widely-parted layers of Schneiderian membrane belonging to the septum. It did not extend quite to the back of the septum, or to the floor of the nostrils (*sic*), between which and the tumour the cartilaginous part of the septum lay crumpled but otherwise healthy. It was incorporated with the base of the cranium from the lower part of the body and right internal pterygoid process of the sphenoid forward, the crista galli being involved in the disease, but not the cribriform plate of the ethmoid bone.

[1] The Resection of the Upper Jaw, Berlin, 1857, 17.

the adult bone this thickness is shifted, so to speak, to its margins.[1] In other words, a marked degree of vascularity is present at a point remote from the centre. Familiar instances of this are seen in the superior angle of the occipital bone, the great wing of the sphenoid, and the orbital plate of the malar. In consequence of such an arrangement, by the time the sutures are accurately adapted, vascular activity is most pronounced along their lines, and continues so throughout adult life.[2] This applies more particularly to flat bones. In diseased action a premature accession to the stage of sutural union causes thinning in the body of the affected bone, the area of deficiency always lying somewhere between that for the centre of ossification and the borders of the bone, though it may involve the latter.[3]

(*f.*) In the long bones the centres of ossification, while losing identity in form, may maintain a peculiar independence of action. Thus, in dislocation of the adult femur on the dorsum of the ilium, the epiphysis has remained displaced after the reduction of the shaft. Epiphyses may separate spontaneously in osteo-myelitis. In fracture of the neck of the femur, that portion of the neck attached to the epiphysis may become absorbed, restoring to the epiphysis its original contour. In chronic arthritis, a series of morbid phenomena are restricted near to or within the epiphysal extremities of the bones. A sequestrum may be restricted to the diaphysis. Indeed this is the rule, the extremities of a bone rarely becoming involved. On the other hand sequestræ may be formed within the epiphyses themselves.[4] Disease of epiphyses impairs the growth of the shaft, as *per contra* disease of the shaft affects the growth of the epiphyses. The centre of ossification of an epiphysis may become necrosed.[5] Many joint diseases have their origin in their contiguous epiphyses. The region of the knee-joint, for example, is limited by the epiphysis of the femur above and by that of the tibia below. These with the patella and intervening synovial membrane make up an aggregate within which diseased action, more especially its chronic expression, finds an area insulated in part (by its origin, nerve and blood supply, and method of growth) from those of the adjoined diaphyses.

(*g.*) In some localities, as in the neck of the femur and in the outer wall of the orbit, we find that atrophy is one of the most constant characters of advanced age. It will be seen that in both these localities we have terminal areas of growth: in the first the end of the shaft of the femur, in the second the lines of junction of the greater wing of sphenoid with the orbital process of malar. It would here appear as though the part last formed was the first to give way, and that in these instances, at least, evidence of retrograde activity is most marked along the lines of progressive activity.

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[1] Humphrey, Treatise on the Skeleton, 186.

[2] Gibson maintained that the sutures exist as the result of the meeting of opposing forces of growth. It would appear, therefore, that the thickening of the bones at their points of contact occurs only where they are instances of *sutura vera* and *harmonia*, as opposed to those of *sutura squamosa*.

[3] Thomas Smith, Trans. Path. Soc., London, 1865, 224; also, a Specimen in W. & H. Museum.

[4] Brodie, Surg. Lectures, 222. W. Adams, Trans. Path. Soc., III. 165.

[5] Birkett, Trans. Path. Soc., London, 1826, vi. 288. Cat. to Mus. Guy's Hos., No. 1484, 49.

(2.) VASCULAR SUPPLY.—*Vascular currents, while determined by the needs of the tissues in which they terminate, may also modify, under diseased action, the region through which they pass.*

Thus, the spheno-parietal suture disappears at an early date, and the tract of the great meningeal artery is a favourite area for ossific change,[1] as also is the outer plate of pterygoid process and the external angle of the frontal bone.[2]

The malar bone and the posterior portion of the superior maxillary, at points where they are perforated by their respective arteries, viz., the malar branches of infra-orbital and the alveolar branches of the internal maxillary, are liable to similar changes—the former in the young subject more especially, where the malar is proportionately thick and vascular, the latter, in the senile subject, where the parts about the foramina are often rugose. This last may be of rheumatic origin.

In two of the most noted instances of facio-cranial exostosis on record, viz., those of Murchison[3] and Lebert,[4] in the one enormous outgrowths appear in the malar bones, while in the other they are but slightly involved.

The direction of a vessel will often decide the locality of an inflammation, and conditions being favourable, that of a sequestrum also. Thus, the nutritive vessel of the shaft of the femur being directed upwards, medullitis is more apt to be located toward the proximal than toward the distal region of the medullary canal. The corresponding artery of the tibia, on the other hand, running as it does downwards, will determine the situation of the tibial medullitis at its distal end.[5]

In specimens of fracture of the long bones the fragment remote from the main source of vascular supply is liable to undergo atrophy.

Atrophy, however, may occasionally take place in a marked degree within an area supplied with a main bloodvessel. As, for example, in the proximal end of the femur in cases of coxalgia, with loss of head of bone from caries. Such specimens quite constantly exhibit numbers of minute foramina, which we have denominated for convenience the foramina of absorption. They are of a rounded form, closely aggregated, the bone being smooth in the interstices.

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[1] Specimen in Cabinet of Dr. W. W. Keen, showing syphilitic ostitis of zygomatic surface of great wing of sphenoid.

[2] Lebert's Atlas, pl. clxxv. fig. 3.

[3] Trans. Path. Soc. London, xvii. 243, pl. 10, xii.

[4] Atlas, pl. xxxii. fig. 1.

[5] Nobis, American Journal of the Medical Sciences, 1865, xlix. 43.

Morbid action is most frequent at that part of the bone within which the area of development is the largest and most active. Thus we see necrosis of the femur of the adolescent almost invariably occurring at the lower portion of the femur, since it is here that the greater degree of vascularity is found.

In the humerus its proximal end is under similar circumstances the one prone to disease. Indeed, morbid growths—such as tumours—are rarely found in any other portion of the bone. [See also quotation from H. Gray in preceding part of this paper.]

(3.) RELATIONS OF BONE TO MUSCLE.—*Continual excitation of points of connection of muscles with bones (more especially if such connection be by tendon) may prove to be an exciting cause to disease within such areas.*

Exostoses are often found along lines of intermuscular septa. The "rider's bone" is situated along line of insertion of the femoral adductor muscles. The "exercise bone" is seen on left humerus of Prussian soldiers.[1] The trochanter minor of femur may appear in an exostosed condition, extending along the line of the psoas and internal iliac muscles.[2]

The excitation, however, may not be of the kind or degree to secure hypernutrition as a result. Subject to many influences, among which a taint of the system is perhaps the chief, the same exciting cause may induce destructive changes in the bone itself.

The tendency to the limitation of diseased areas by muscular impressions is in many cases quite noticeable. Specimens are not rare showing the region of the origin of the third head of the triceps muscle to be affected with caries or ostitis while the remainder of the shaft of the humerus has remained in a healthy condition.

A locality on the upper and outer aspect of the upper third of the femur, defined by numerous punctate foramina, occasionally produces a pedunculate exostosis.

The influence of muscles in determining disease of the cranial surfaces is less pronounced than in the bones of the extremities.

The following localities are frequently the seat of minute hyperostoses: Inferior margin of malar, from masseter muscle; mastoid process, from sterno-cleido-mastoid muscle; occipital protuberance and crest, from nuchal ligament and post-cervical muscles.

The impression of the temporal muscle is smoother than other portions of the cranium, and is rarely the seat of diseased action. The same may be said of the impressions on occipital bone. In the specimens of cranio-facial exostosis of Murchison and Lebert, this region is entirely free from osteophytes.

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[1] Virchow, Osseous Tumours, vol. ii. 72.

[2] Birkett, Guy's Hospital Report, 1868, xiv. 499.

The inter-temporal space—a region including median portion of vertex, and extending thence downwards and backwards to and behind the mastoid portion of the temporal bone, is less protected by muscular masses than other portions of the skull. It is owing to this fact that we frequently find here striking examples of excitation, probably of traumatic origin. In a specimen in the Wistar and Horner Museum, the space between the impressions of the temporal and post-cervical muscles was the seat of a well-defined sclerous exostosis.

The liability of the space between the mastoid process and foramen magnum to become inflated, exostosed (pneumatic process), or depressed, leads us to conjecture whether there may not be some connection between this area and the projection of the para-mastoid process in the hog and horse. The tendency of the mastoid process to become carious in adolescence, and frequently to undergo partial atrophy in advanced life, is suggestive of the fact that this process is peculiar to man, and it may be that one of the causes of its easy obedience to life changes is in some way associated with its zoological significance. The same may be said of the fixed styloid process which becomes exostosed during senility. The *lingula sphenoidalis* becomes inflated in old age. There is a suspicion that naso-pharyngeal polypus at times originates from this region.[1]

For the sake of illustrating in a particular bone the application of the foregoing propositions, let us select the lower jaw, endeavoring to account for its diseases in this manner.

The lower jaw is a symmetrical bone, the two halves arising independently of one another.

Its power, so to speak, resides in its halves, and not at or near the symphysis. Tumours are found, therefore, rarely at the median line. Excluding the gum tumours, which form a separate group, the only growth occurring at the symphysis is an occasional exostosis.[2] The alveolar region being designed especially to accommodate the teeth,[3] furnishes distinctive features in its vascularity, and in its contact with a mucous surface; hence arises a distinct group of tumours for this region—the dental tumours and the epulides. Exclusive of the alveolar region the lower jaw has thick compact walls with little cancellated structure; hence caries is uncommon, while necrosis is relatively frequent. It is without epiphyses; hence diseases of the joints are rare. It is a membranous bone; hence fibrous tumours are common, but the cartilaginous are rare. It is a vascular bone; hence encephaloid is more frequent than scirrhus. Primary scirrhus is one of the rarest of maxillary tumours. The angle of the jaw is subject to great muscular traction, through the masseter, internal pterygoid, and temporal muscles; hence this region is prolific in fibroid and cystic tumours. In addition, it is curious to remark, the greater potentiality (?) possessed by the right side of the bone. Tumours of all kinds are more frequent on this side.

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[1] Guerin, Gaz. des Hôp. 1865, 375, Syd. Soc. Retros. 1867, 241.

[2] Hyrtl, Topograph. Anat., i. 324.

[3] "The alveolar processes of both jaws should rather be considered as belonging to the teeth, than as parts of the jaws." Palmer's Hunter, vol i. p. 4.

In the region of the head of the tibia, noted for its tendency to disease, we find among other causes the following: Its cancellated structure predisposes it to strumous deposit, cancer, caries, inflammation and its consequences. · The protracted activity of the epiphysis as a distinct centre sustains the vascularity for an unusual period. The large area covered by the epiphysis causes in its disorders tendencies to articular complications. The numerous and powerful muscular connections conjoined to the comparatively slight protection, secured to the part through the surrounding skin and connective tissue, lead to development of tumours, more especially the exostoses.

Such are some of the relations which appear to obtain between methods of development, growth, habit, vascularity, etc., and localization of diseased action in the osseous system. They are, it is acknowledged, meagre. Believing, however, that every biological principle must be proved by the test of pathology, there is a strong probability that eventually we may arrive at something of decided value.

ART. XII.—*Hydrencephalocele Radically Cured.* By DANIEL LEASURE, M. D., of Alleghany City, Pa., late of New Castle, Pa.

I WAS called January 24th, 1870, to see P. P., female, aged fifteen months, labouring under occipital spina bifida, or hydrencephalocele. When two weeks old, she had been treated by a surgeon of high repute in a western city, where the parents then resided, but without success. When I saw her, she had a tumour, nine inches in circumference, occupying the lower central portion of the occipital region. On lifting up the tumour, and passing the fingers up underneath its pendent portion, a foramen in the occipital bone could be distinctly felt about an inch in its lateral diameter, and situated in the lower third of that bone, but I could not determine positively whether it extended near, or quite to the foramen magnum, owing to the thickness of the integumentary and muscular covering at that part. The fluid contents of the tumour communicated freely with the cavity of the cranium, and at one time, the parents inform me, that during a severe indisposition, in which the child seemed to labour under some cerebral disturbance, the *tumour shrunk up* to less than half its ordinary size. This, I take it, would argue, that whatever may have